CLAIMS

1.   A re-transmission control method for transmitting a codeword encoded at a predetermined coding rate during an initial transmission, and for transmitting an additional parity during a re-transmission, the method comprising:

a parity-check matrix generation step of causing a transmitter-side communication device that has received a NAK from a receiver-side communication device to generate a parity-check matrix for the re-transmission so as to include, as a part of the parity-check matrix for the re-transmission, a check matrix (configured by a check symbol generator matrix P and a unit matrix) in an irreducible standard form obtained by transforming a parity-check matrix for the initial transmission;

a check matrix transforming step of transforming the parity-check matrix for the re-transmission into a check matrix (configured by a check symbol generator matrix $(P+P')$ and the unit matrix) in the irreducible standard form;

a generator matrix generation step of generating a generator matrix in the irreducible standard form for the re-transmission, which matrix includes the check symbol generator matrix $(P+P')$;

an additional parity generation and transmission step of generating the additional parity $(=P' \times m)$ using the generator matrix P' and a message m having a fixed length, performing a predetermined digital modulation on the generated additional parity, and transmitting a modulated signal; and

a decoding step of causing the receiver-side communication device to perform a predetermined digital demodulation on the received modulated signal, to perform a decoding process by combining data received during the

initial transmission and stored in advance with the demodulated additional parity, and, when the data received during the initial transmission cannot be normally decoded, to transmit the NAK to the transmitter-side communication device, wherein

the transmitter-side communication device that has received the NAK repeatedly executes the parity-check matrix generation step, the check matrix transforming step, the generator matrix generation step, and the additional parity generation and transmission step while reducing the coding rate until the receiver-side communication device transmits an ACK to the transmitter-side communication device, and

the receiver-side communication device repeatedly executes the decoding step while repeating the additional parity combining processing until the data received during the initial transmission can be normally decoded.

2. The re-transmission control method according to claim 1, wherein

at the parity-check matrix generation step, the parity-check matrix for the re-transmission is generated so as to include, as the part of the parity-check matrix for the re-transmission, the check matrix in the irreducible standard form for the initial transmission under constraint conditions that "the parity-check matrix for the re-transmission is linearly independent", "the number of columns of the parity-check matrix for the initial transmission is smaller than the number of columns of the parity-check matrix for the re-transmission", "the number of rows of the parity-check matrix for the initial transmission is smaller than the number of rows of the parity-check matrix for the re-transmission", and "a sum of

differences between SNRs corresponding to parity-check
matrices according to respective coding rates and the
Shannon limit is minimum (optimum)".

5　3.　The re-transmission control method according to claim
2, wherein
　　　at the parity-check matrix generation step, during
generation of the parity-check matrix for the re-
transmission, the number of added rows and the number of
10　added columns are determined according to system
requirement conditions.

　　4.　The re-transmission control method according to claim
3, wherein
15　　　at the parity-check matrix generation step, during the
generation of the parity-check matrix for the re-
transmission, a zero matrix corresponding to the determined
number of columns is added.

20　5.　The re-transmission control method according to claim
1, wherein
　　　when the received data during each of the initial
transmission and the re-transmission can be normally
decoded, then the receiver-side communication device
25　includes the number of errors corrected during decoding in
the ACK, and the transmitter-side communication device
updates the coding rate to an optimum value according to
the number of errors.

30　6.　A communication device for transmitting a codeword
encoded at a predetermined coding rate during an initial
transmission, and for transmitting an additional parity
during a re-transmission, comprising:

an encoding unit that, when the communication device receives a NAK from a receiver-side communication device, generates a parity-check matrix for the re-transmission so as to include, as a part of the parity-check matrix for the

5   re-transmission, a check matrix (configured by a check symbol generator matrix P and a unit matrix) in an irreducible standard form obtained by transforming a parity-check matrix for the initial transmission, that transforms the parity-check matrix for the re-transmission

10 into a check matrix (configured by a check symbol generator matrix (P+P') and the unit matrix) in the irreducible standard form, that generates a generator matrix in the irreducible standard form for the re-transmission, which matrix includes the check symbol generator matrix (P+P'),

15 and that generates the additional parity (=P'× m) using the generator matrix P' and a message m having a fixed length; and

a modulation unit that performs a predetermined digital modulation on the additional parity, and that

20 transmits the modulated additional parity, wherein the communication device repeatedly executes processings by the encoding unit and the modulation unit while reducing the coding rate until the receiver-side communication device transmits an ACK to the communication

25 device.

7.   The communication device according to claim 6, wherein the encoding unit generates the parity-check matrix for the re-transmission so as to include, as the part of

30 the parity-check matrix for the re-transmission, the check matrix in the irreducible standard form for the initial transmission under constraint conditions that "the parity-check matrix for the re-transmission is linearly

independent", "the number of columns of the parity-check
matrix for the initial transmission is smaller than the
number of columns of the parity-check matrix for the re-
transmission", "the number of rows of the parity-check
5 matrix for the initial transmission is smaller than the
number of rows of the parity-check matrix for the re-
transmission", and "a sum of differences between SNRs
corresponding to parity-check matrices according to
respective coding rates and the Shannon limit is minimum
10 (optimum)".

8. The communication device according to claim 7, wherein
during generation of the parity-check matrix for the
re-transmission, the encoding unit determines the number of
15 added rows and the number of added columns according to
system requirement conditions.

9. The communication device according to claim 8, wherein
during the generation of the parity-check matrix for
20 the re-transmission, the encoding unit ads a zero matrix
corresponding to the determined number of columns.

10. The communication device according to claim 6, wherein
when the communication device receives the ACK
25 including the number of errors corrected during decoding
from the receiver-side communication device, the encoding
unit updates the coding rate to an optimum value according
to the number of errors.